Near Electronics: Progress, Costs and Decisions

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Vertical Slice

- Hardware
  - RIO-3 and PVIC from mine
  - Linux box for mBRP,Trigger, Run control, GUI
- 2nd Teststand
  - Includes Timing crate
- Software
  - Dave, Tim, Tass
  - Load and correct thru LUT
  - DAQ framework
    - Utilizes ND dual interrupt buffer swaps
    - Interface to Front-end specific code in progress

Vertical Slice

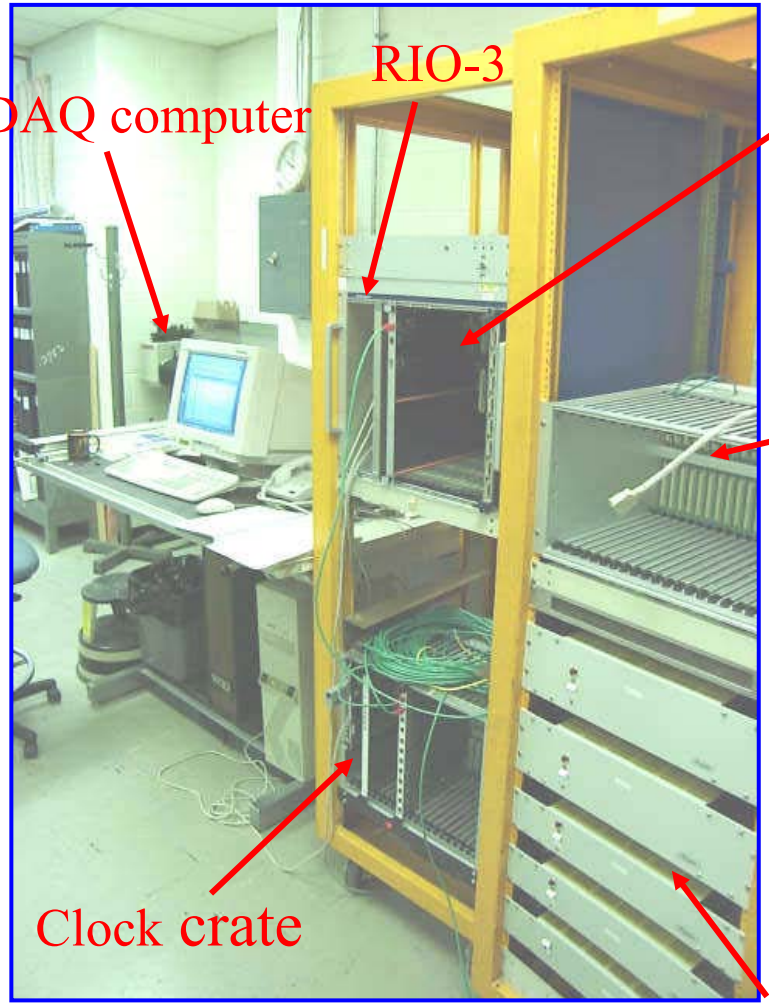
Two Teststands

How can I work here AND at the mine?

You think that will work?!

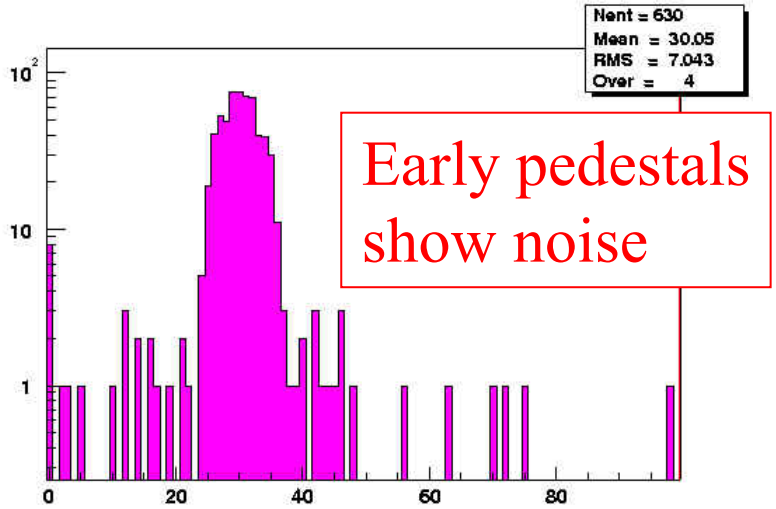
Experts at work

Vertical Slice

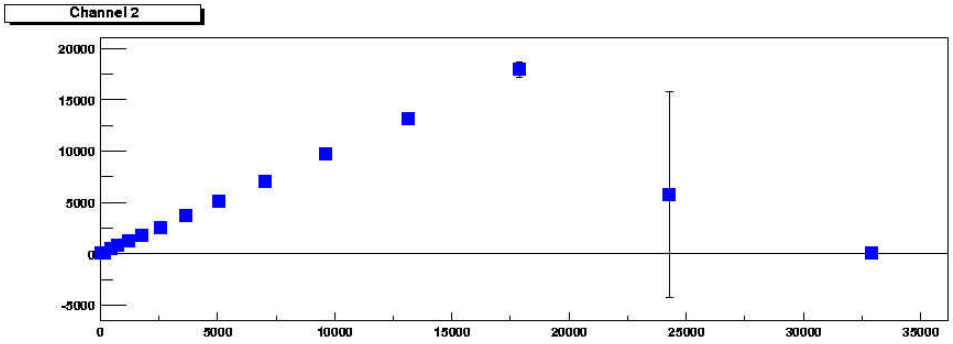


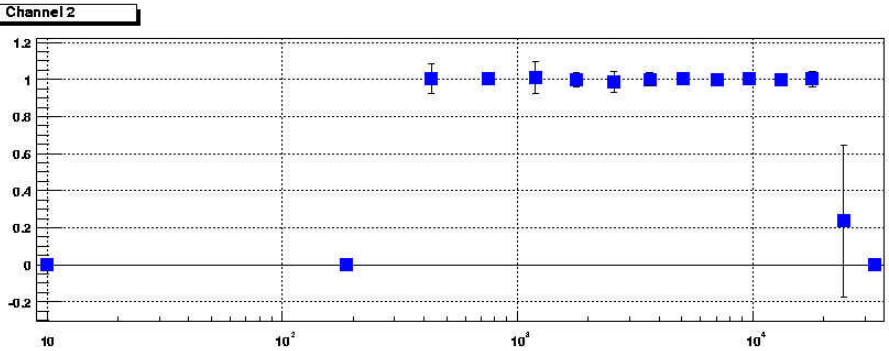
Full MINDER

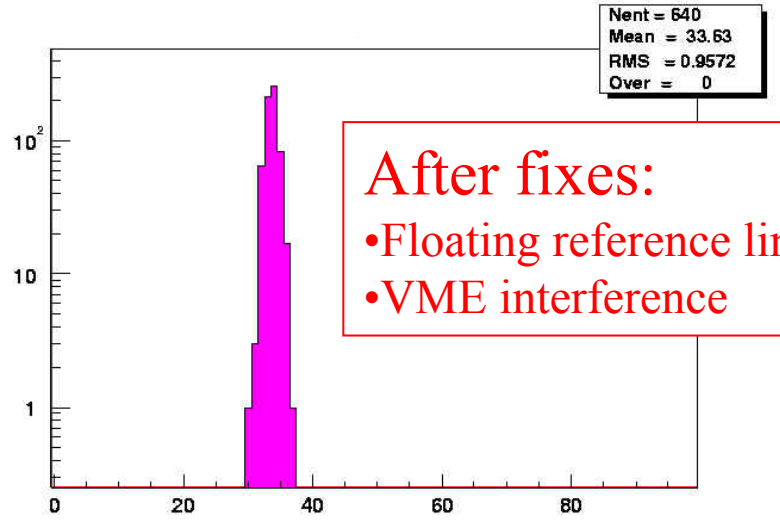
Vertical Slice Results



Early pedestals show noise







After fixes:

- Floating reference line
- VME interference

- DC current calibration
- Calculate and load LUT
- Use LUT in Data mode

Progress - Boards

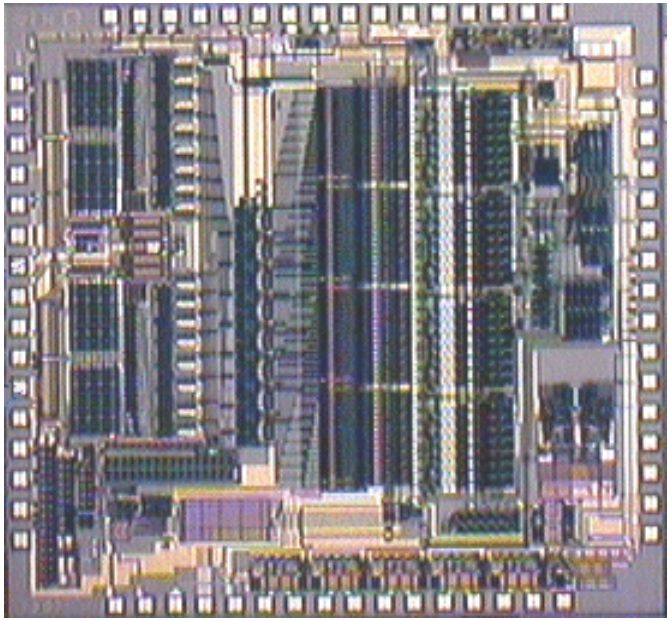
- Menu
  - Charlie design
    - Data align, delay w/ANL CPLD - ~5x19ns for trig
    - Remove current buffer
  - Producing 70 for vert. slice - old type – being assembled at FNAL
  - Digital MENU – outputs fixed data
- Other boards
  - Keeper - No more ASD-Lites, too slow, sensitive to input cap
  - MINDER – tune timing
- Some of the problems found
  - Bit swap, noise from VME trig, cap on input, both input

Progress - 2

- Clock
  - Master control
    - Interfaces to MI
    - Lock on to MI faster than needed , holds frequency of flattop
    - Test w/ 'MI emulator'
    - Working on CalDet modification
  - Master fanout
  - VTM –clock to MASTER, interrupts for buffer swap
  - MTM – clock to MINDERs
- MINDER PS
  - Switcher vs. linear vs. 400Hz
    - Wiener can do linear in 5U
  - ND Installation OK with all placements
  - Won't be used for this CalDet run

QIE 7B

- Production Chips arrive
  - 48 wafers, 700/wafer (× yld)
- Results of testing - FNAL
  - Ready to test, final tune of setup
  - Can test from die or package
  - 2 wafer/day, 2 chip/min
  - 1st 10 of 10 look good!
  - People to help, look at data
- 1000 by early February



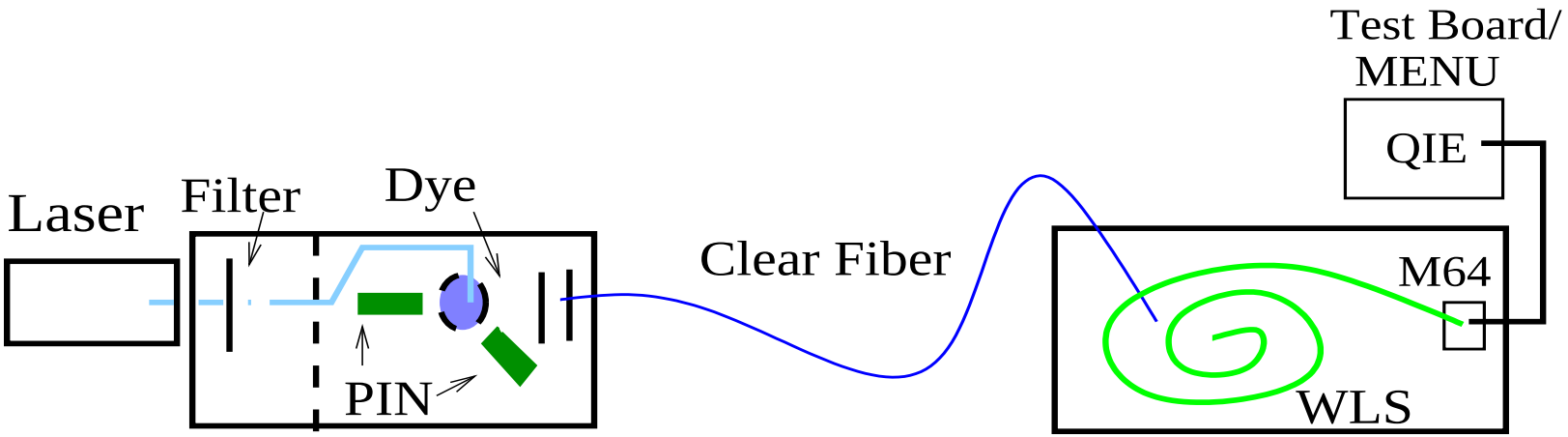
QIE Response Issues

- Pulse shape distortion:
  - Input impedance change with current – 'current buffer' on chip
- Clock edge
  - Nonlinearities as rising edge overlapped clock edge – KTeV had significant effect
- Single Photo-Electron Response
  - Clock edge could cut, go below threshold

Current Buffer circuit on MENU?

Capacitors on PMT base to stretch pulse shape?

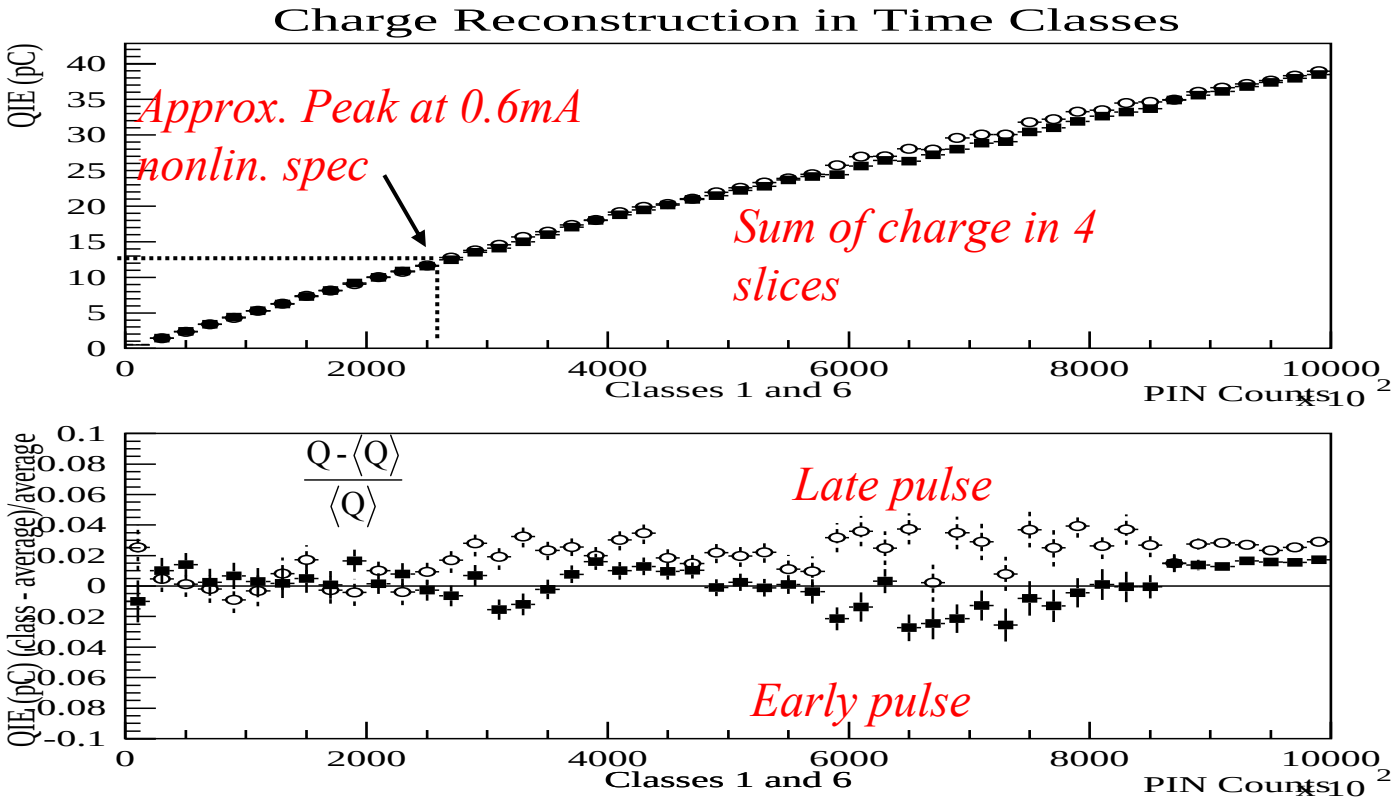
Laser Test Stand



- General purpose test stand
  - Adapted for MINOS requirement
  - POPOP solution excited by Nitrogen laser
  - PIN Diodes with 20-bit DDC101 ADCs
    - Used to measure input light
    - TDC measures time of pulse
  - Determine pulse position wrt clock edge

QIE Response

- Run over large dynamic range
- Random times within clock period



QIE Response - Conclusions

- Good pulse shape stability
  - Response linear for all pulse charges
  - Current Buffer – Not needed
- Clock edge distortions
  - <5% effects in response among different timings with respect to clock edge
  - MC studies showed negligible effect on neutrino events with larger distortions
  - Worst above realistic dynamic range
  - Anode Capacitor - Not needed

Plans

- Place CalDet orders – January
  - CalDet now ≤1 crate worth (100-300 channels)
- Vertical slice continues and expands
  - CalDet people come Argonne/FNAL to learn
- Electronics to CalDet - June

DCS, HV

- DCS
  - Delay of RPS
    - Holding up unattended running
    - One arrived at Duluth!
  - Old RPS - Noise at mine
  - Radon, temp, press
  - Work on software integration GUI
- HV software, all mainframes

Near Cost Estimate

- Bottoms ups cost from Engineers
- Several rounds w/management
  - Aesook: sharp pencil, eye on bottom line
  - Cut back on 'spares'
    - Complete boards: 10%
    - Parts: 5%, MENU 3%
    - 'Dogs', Teststand: 0%
  - Assume purchasing agent gets discount
    - Based on CDF experience
  - Had hoped 2 QIE/MENU
    - Too much heat
    - Couldn't get FNAL to put data aligner on chip
- Very Success Oriented
  - Will have to repair right away

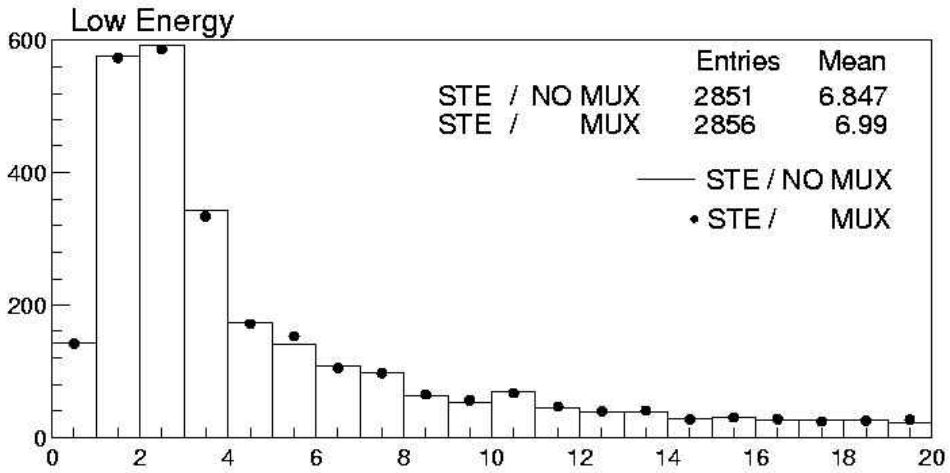
Near Front-End Production Cost

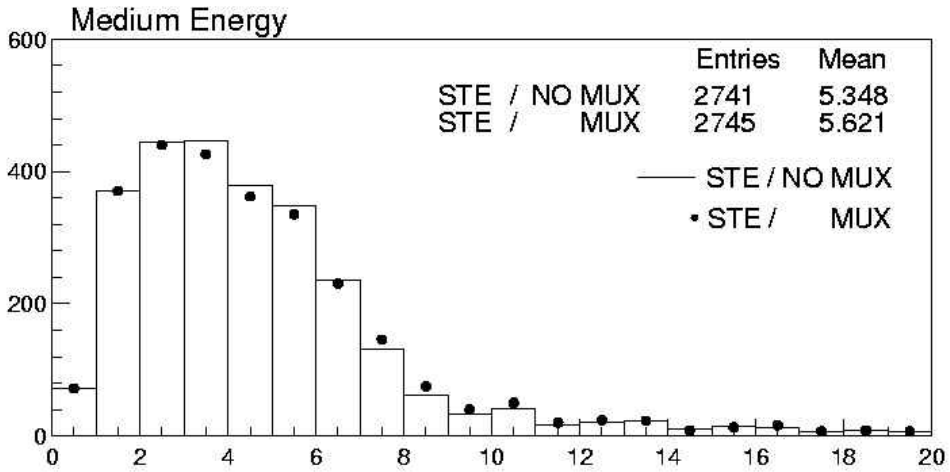
Item	Baseline	New Estimate	Increase	Comments
Parts & Assembly	**$1,931**	**$2,514**	**$583**	
Master, Minder, Keeper, PS,…	$767	$1,317	$550	PS↑,more boards
QIE, MENU	$1,165	$1,197	$32	QIE↓,MENU↑
Checkout	**$246**	**$246**	**$0**	
ANL	$42	$98	$56	
FNAL	$204	$148	-$56	
Clock Dist.	**$27**	**$101**	**$74**	Was based on old Far cost
TOTAL	**$2204**	**$2861**	**$657**	

DeMux'ing the Near Spectrometer

- Pro
  - Less confusion on tracking
- Con
  - Cost
- Implementation
  - 'Wired' on PMT base
  - Limited range of which channels can be connected
  - Muxing between planes, LI patterns…

DeMux'ing: Track Momentum





From NuMI-630

Shift of:

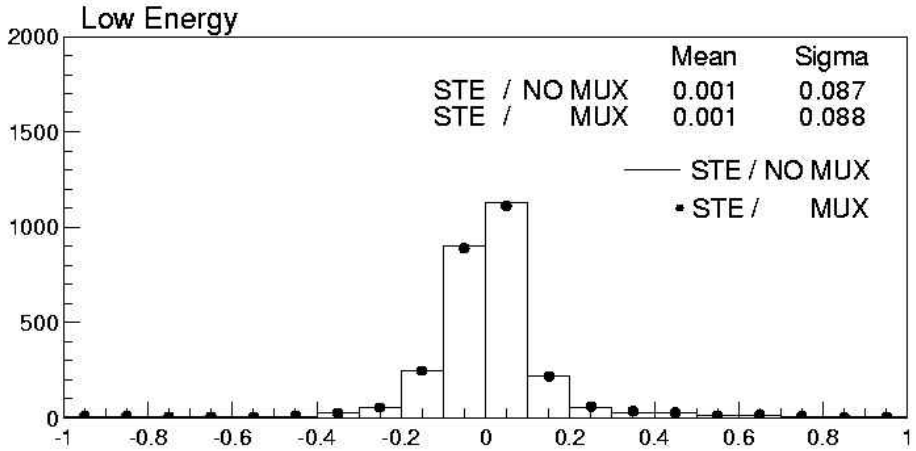
LE – 2.1%

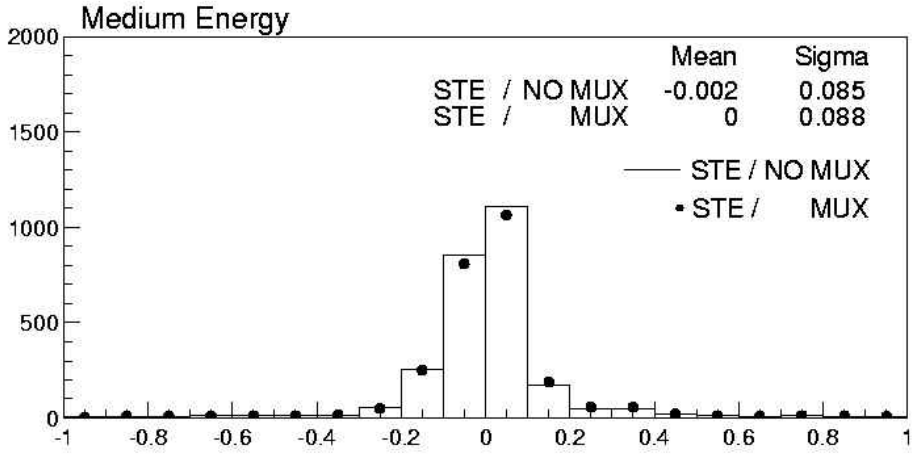
ME – 5.1%

- Includes range and curvature
- Main effect is adding hits at the end of a track.

DeMux'ing: Momentum Resolution

$(p_{FIT} - p_{MC}) / p_{MC}$





Increase small compared to
Range and Curvature measurement

Also…
Very little effect on shower energy
and reconstruction efficiency

Demux'ing

28	15	2	53	40	27	14	1
4	55	42	29	16	3	54	41
44	31	18	5	56	43	30	17
20	7	58	45	32	19	6	57
60	47	34	21	8	59	46	33
36	23	10	61	48	35	22	9
12	63	50	37	24	11	62	49
52	39	26	13	64	51	38	25

Fibers to pixels

PMT mux'es within plane

Closest mux

11	11	11	13
11	13	11	11
11	11	11	11
11	11	13	11

OK

Demux'ing

28	15	2	21	8	27	14	1
4	23	10	29	16	3	22	9
12	31	18	5	24	11	30	17
20	7	26	13	32	19	6	25
28	15	2	21	8	27	14	1
4	23	10	29	16	3	22	9
12	31	18	5	24	11	30	17
20	7	26	13	32	19	6	25

- **But, <u>two planes mux'ed together</u>!**
- Less separation

- Possible to improve pattern
- Buy more PMT's to avoid
- ?

13 5	27 8	13 5	13 5
11 5	13 5	13 5	11 5
13 5	11 8	11 5	13 5
11 5	13 5	13 5	11 5

Spectrometer Demux: Costs

Item	Quantity Needed to Demux	Total
Minder Crate	8	$ 15,471
J2 Backplane	8	$ 4,217
Power Supply	8	$ 32,380
Keeper	8	$ 7,391
ASD-Lite	32	$ 160
MTM	8	$ 3,369
Master-Keeper cable	8	$ 600
MTM-MCF cable	8	$ 320
Minder Card	148	$ 76,871
MENU	2368	$ 221,645
Minder Aux, cable	148	$ 18,543
Minder-Master cable	148	$ 7,400
Minder-MTM cable	148	$ 2,960
Master Card	24	$ 96,736
Total		**$ 488,063**
Total w/Overheads		**$ 574,735**

- Incremental costs
- Based on latest Near Elec cost est.
- FNAL overhead rates

- Check signal from muxed PMT
- Resolve pattern problems

- If OK, Recommend Not to Build all of it. May need some for pattern Problems.

Permanent CalDet Near Electronics

- Pro
  - Can do aging studies later
  - Can check again if problem found
  - Once Near Det. is installed, won't be enough spares
- Con
  - Cost
  - May never be used
- Alternatives
  - Use spares for partial readout
  - Build more later – incurs more costs
- Time scales- Far, then Near, mid-Sep, then 2003

Cost Assumptions

- 60 planes, 24 strips/plane
- 1 Alner box / 2 planes ($\Rightarrow$ only 3 Minder/box)
- 24 chan Pin diodes
- 4 Alner boxes for Cosmic counters
- 1 Minder for Cerenkov, ToF
- Based on latest Near Elec. cost estimate
- Incremental costs
- FNAL overhead rates
- Use DAQ from Far readout

CalDet Electronics: Cost

Item	Quantity	Total
Minder Crate	7	$ 13,537
J2 Backplane	7	$ 3,690
Power Supply	7	$ 28,333
Keeper	7	$ 6,467
ASD-Lite	28	$ 140
MTM	7	$ 2,948
Master-Keeper cable	7	$ 525
MTM-MCF cable	7	$ 280
Minder Card	105	$ 54,537
MENU	1680	$ 157,248
Minder Aux, cable	105	$ 13,155
Minder-Master cable	105	$ 5,250
Minder-MTM cable	105	$ 2,100
Pin diode board	2	$ 1,262

Item	Quantity	Total
Master Card	14	$ 56,429
Master Crate	2	$ 7,065
Master Power supply	2	$ 8,165
VTM	2	$ 1,640
MCF-VTM Cables	2	$ 80
Master Clock Cntrl	1	$ 1,023
Master Clock Fanout	1	$ 2,739
VME crate		$ 0
VME processor		$ 0
RIO-3	2	$ 0
PVIC branch	2	$ 0
Total		$ 366,613
Total w/ Overhead		**$ 431,526**

Recommend Not to Build

The End